CLAIMS

What is claimed is:

1. An optical switching device, comprising:

a substrate;

a first waveguide disposed on the substrate, the first waveguide capable of carrying an optical signal;

a second waveguide disposed on the substrate, the second waveguide capable of carrying the optical signal, the second waveguide intersecting the first waveguide at an angle to define an intersection region;

means for diverting at least a portion of the optical signal from one of said waveguides to the other waveguide at the intersection region; and

means for reflecting the portion of the optical signal when the portion of the optical signal is in one of said waveguides.

2. An optical switching device as defined in claim 1, wherein said means for diverting at least a portion of the optical signal is capable of selectively altering the index of refraction of at least a portion of the first and second waveguides that define the intersection region.

3. An optical switching device as defined in claim 1, wherein said means for diverting at least a portion of the optical signal comprises a thermal element that is located proximate the intersection region and is capable of being selectively heated.

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4. An optical switching device as defined in claim 3, wherein the thermal element is disposed atop approximately one-half of the intersection region.

5. An optical switching device as defined in claim 3, wherein the thermal element comprises an electrode heater having a substantially rectangular shape.

6. An optical switching device as defined in claim 3, wherein a cladding material is interposed between the intersection region of the waveguides and the thermal element.

7. An optical switching device as defined in claim 1, wherein said means for reflecting comprises:

a reflective element located at one end of the first waveguide that reflects an optical signal incident thereon back along the first waveguide.

8. An optical switching device as defined in claim 2, wherein the substrate comprises a semiconductor material.

9. An optical switching device as defined in claim 8, wherein the means for diverting at least a portion of the optical signal comprises a semiconductor superlattice structure located in the intersection region.

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10. An optical switching device as defined in claim 1, wherein the means for diverting at least a portion of the optical signal comprises a liquid crystal structure located in the intersection region.

11. An optical switching device as defined in claim 1, wherein the second waveguide further comprises an outlet end, and wherein optical signals that are diverted from the first to the second waveguide exit the second waveguide at the outlet end.

12. An optical switching device as defined in claim 1, wherein the magnitude of the angle defined by the intersection of the first and second waveguides is between two and six degrees.

13. An optical switching device as defined in claim 1, further comprising a detector that monitors the amount of light in at least one of the waveguides.

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14. A method of redirecting optical signals within an optical switch, the optical switch including first and second waveguides disposed on a substrate, the first and second waveguides intersecting at an angle to form an intersection region, the method comprising:

introducing a first optical signal into a first end of the first waveguide;

maintaining a diverting element located at the intersection region in an inactive state such that the first optical signal passes through the intersection region and remains in the first waveguide; and

reflecting the first optical signal at a second end of the first waveguide such that the first optical signal is redirected along the first waveguide and exits the optical switch via the first end of the first waveguide.

15. A method of redirecting optical signals as defined in claim 14, further comprising:

introducing a second optical signal into the first end of the first waveguide; and

activating the diverting element such that a predetermined portion of the second optical signal is redirected from the first waveguide to the second waveguide at the intersection region.

16. A method of redirecting optical signals as defined in claim 15, further comprising:

passing the predetermined portion of the second optical signal through an end of the second waveguide such that it exits the optical switch.

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17. A method of redirecting optical signals as defined in claim 15, wherein activating the diverting element further comprises:

activating the diverting element such that the index of refraction at the intersection region is altered.

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18. A communications system including a plurality of optical switches, each optical switch comprising:

a substrate;

a first waveguide disposed on the substrate, the first waveguide capable of carrying an optical signal;

a second waveguide disposed on the substrate, the second waveguide capable of carrying the optical signal, the second waveguide intersecting the first waveguide at an angle to define an intersection region;

a diverting element , wherein the diverting element in an activated state can alter the index of refraction of the portion of the intersection region such that a predetermined portion of the optical signal in one of said waveguides is diverted at the intersection region from one of said waveguides to the other waveguide; and

a reflective element disposed at a terminal end of the first waveguide, wherein the reflective element reflects optical signals incident on the reflective element back along the first waveguide.

19. A communications system as defined in claim 18, wherein the diverting element diverts the predetermined portion of the optical signal from the first waveguide to the second waveguide, and wherein the diverting element passes a remainder portion of the optical signal along the first waveguide.

20. A communications system as defined in claim 18, wherein the entirety of the optical signal is diverted at the intersection region from one of said waveguides to the other waveguide.

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21. A communications system as defined in claim 18, wherein the diverting element comprises an electrode heater.

22. A communications system as defined in claim 18, wherein a cladding material is interposed between the intersection region of the waveguides and the diverting element.

23. A communications system as defined in claim 18, wherein the diverting element includes a liquid crystal structure located at the intersection region, the liquid crystal structure having a refractive index that can be modified by applying a voltage to a conductive electrode attached to the liquid crystal structure.

24. A communications system as defined in claim 18, wherein the diverting element includes a semiconductor superlattice structure located at the intersection region, the superlattice structure having a refractive index that can be modified by applying a voltage to the superlattice structure.

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25. A communications system as defined in claim 18, wherein the amount of diversion of the optical signal from one of said waveguides to the other waveguide is at least partially determined by the extent of modification of the refractive index by the diverting element.

26. An optical switch for use in transmitting an optical signal, the optical switch comprising:

a first waveguide disposed on a substrate, the first waveguide including an inlet end for receiving the optical signal;

a plurality of secondary waveguides, each secondary waveguide disposed on the substrate and intersecting the first waveguide at an angle to define a plurality of intersection regions; and

a diverting element corresponding to each intersection region, each diverting element capable of diverting a predetermined portion of the optical signal from the first waveguide to the respective secondary waveguide.

27. An optical switch as defined in claim 26, further comprising:

a reflective component disposed at a terminal end of at least one of the waveguides, the reflective component operable to reflect optical signals incident upon it.

28. An optical switch as defined in claim 27, wherein the optical signal that is incident upon the reflective component is reflected toward the inlet end of the first waveguide.

29. An optical switch as defined in claim 26, wherein four secondary waveguides are disposed on the substrate.

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30. An optical switch as defined in claim 26, wherein the diverting element is selected from the group consisting of an electrode heater, a liquid crystal structure, and a semiconductor superlattice structure.

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31. An optical switching device, comprising:

a first array of waveguides located on a substrate, each waveguide of the first array capable of carrying optical signals;

a second array of waveguides located on the substrate, each waveguide of the second array capable of carrying optical signals, the waveguides of the second array intersecting the waveguides of the first array at angles to form a plurality of intersection regions between the waveguides of the first array and the waveguides of the second array; and

a plurality of diverting elements, each diverting element corresponding to a respective intersection region and being configured to divert a predetermined portion of one of said optical signals from one of the first array of waveguides to one of the second array of waveguides.

32. An optical switching device as defined in claim 31, further comprising:

a plurality of reflective components, each reflective component located at a terminal end of one of said waveguides to reflect optical signals incident upon it.

33. An optical switching device as defined in claim 31, wherein the waveguides of the first array are parallel to one another on the substrate, and wherein the waveguides of the second array are parallel to one another on the substrate.

34. An optical switching device as defined in claim 31, wherein each waveguide of the first array comprises a first end configured to receive optical signals.

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35. An optical switching device as defined in claim 31, wherein at least one of the diverting elements comprises an electrode heater.

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36. An optical switch, comprising:

a semiconductor substrate;

a first waveguide located on the substrate, the first waveguide suitable for carrying an optical signal;

a second waveguide located on the substrate, the second waveguide suitable for carrying an optical signal, the second waveguide intersecting the first waveguide at an angle so as to define an intersection region;

a cladding material disposed atop the first and second waveguides;

an electrode heater disposed atop the cladding material, the electrode heater being located proximate the intersection region, wherein heating of the electrode heater enables an optical signal to be diverted in the intersection region from one of said waveguides to the other waveguide; and

a high reflective coating disposed at a terminal end of the first waveguide, the high reflective coating operable to reflect in the opposite direction an optical signal passing through the first waveguide that is incident on the high reflective coating.

37. An optical switch as defined in claim 36, wherein the first waveguide, the second waveguide, and the intersection region are configured so as to enable an optical signal to travel either direction along each waveguide.

38. An optical switch as defined in claim 37, wherein the optical signal is introduced into the optical switch via a first end of the first waveguide.

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39. An optical switch as defined in claim 38, wherein the second waveguide further comprises an optical signal outlet, wherein optical signals that are redirected at the intersection region exit the optical switch at the optical signal outlet.

40. An optical switch as defined in claim 39, wherein the optical signal that is reflected by the reflective component exists the optical switch at the first end of the first waveguide.

41. An optical switch as defined in claim 40, wherein the electrode heater is located to provide heating to approximately one-half of the intersection region.

42. An optical switch as defined in claim 41, wherein the coating comprises sodium.

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43. An optical switch, comprising:

a semiconductor substrate;

a first waveguide located on the substrate, the first waveguide suitable for carrying an optical signal;

a second waveguide located on the substrate, the second waveguide suitable for carrying the optical signal, the second waveguide intersecting the first waveguide at an angle so as to define an intersection region; and

a diverting element, including:

a liquid crystal structure located at the intersection region and having a refractive index that can be modified to divert a predetermined portion of the optical signal from the first waveguide to the second waveguide.

44. An optical switch as defined in claim 43, wherein the refractive index of the liquid crystal structure is modified by applying a voltage to a conductive electrode attached to the liquid crystal structure.

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45. An optical switch, comprising:

a semiconductor substrate;

a first waveguide located on the substrate, the first waveguide suitable for carrying an optical signal;

a second waveguide located on the substrate, the second waveguide suitable for carrying an optical signal, the second waveguide intersecting the first waveguide at an angle so as to define an intersection region; and

a diverting element, including:

a semiconductor superlattice structure located at the intersection region and having a refractive index that can be modified to divert a predetermined portion of the optical signal from the first waveguide to the second waveguide.

46. An optical switch as defined in claim 45, wherein the refractive index of the semiconductor superlattice structure is modified by applying a voltage to the semiconductor superlattice structure.

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